NOAA perspective

Sea Ice Modeling Needs and Plans

Dr. Ir. Hendrik L. Tolman
Senior Advisor for Advanced Modeling System (SAAMS)
Office of Science and Technology Integration
National Weather Service /NOAA

Hendrik.Tolman@NOAA.gov

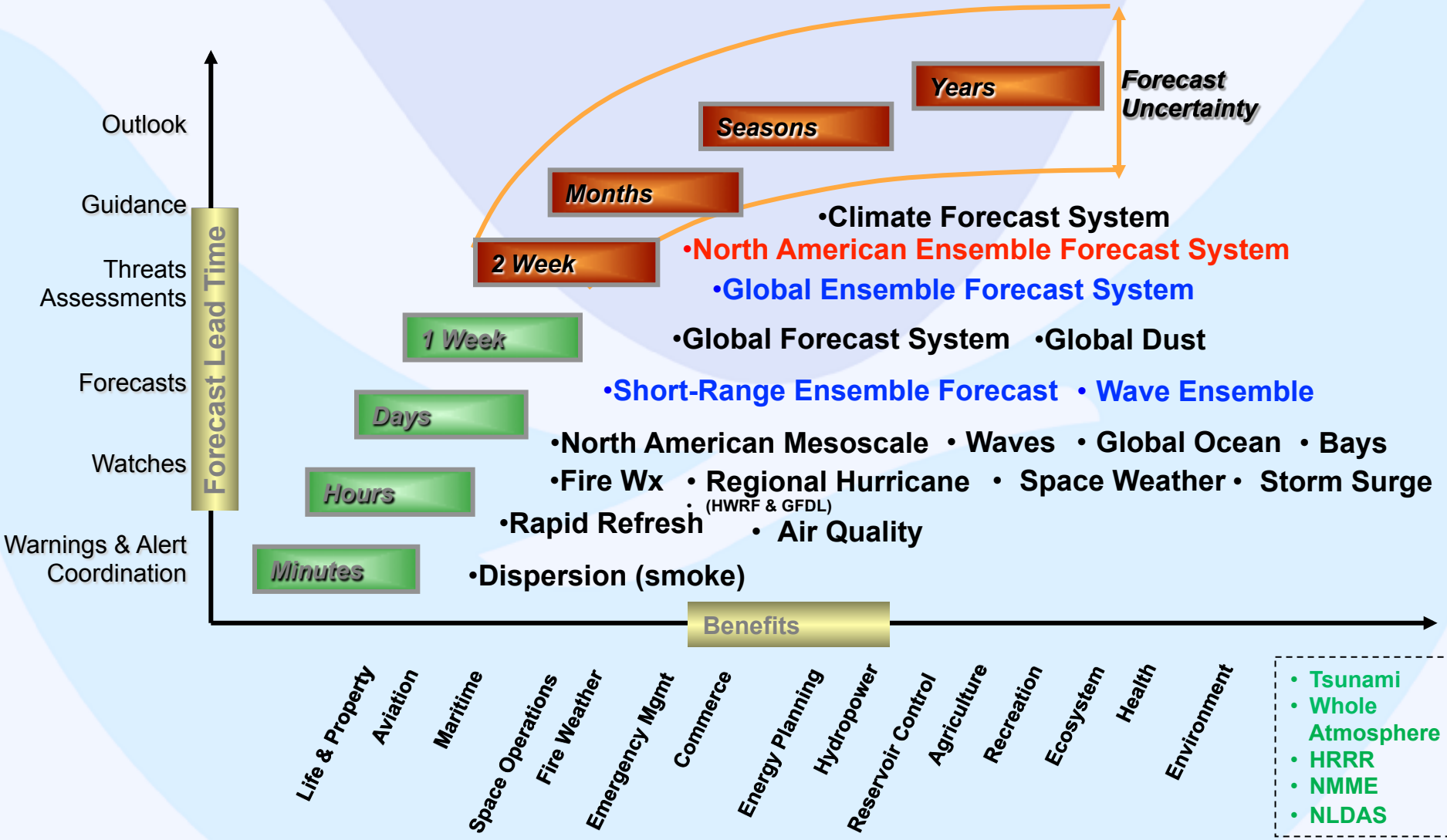
Overview

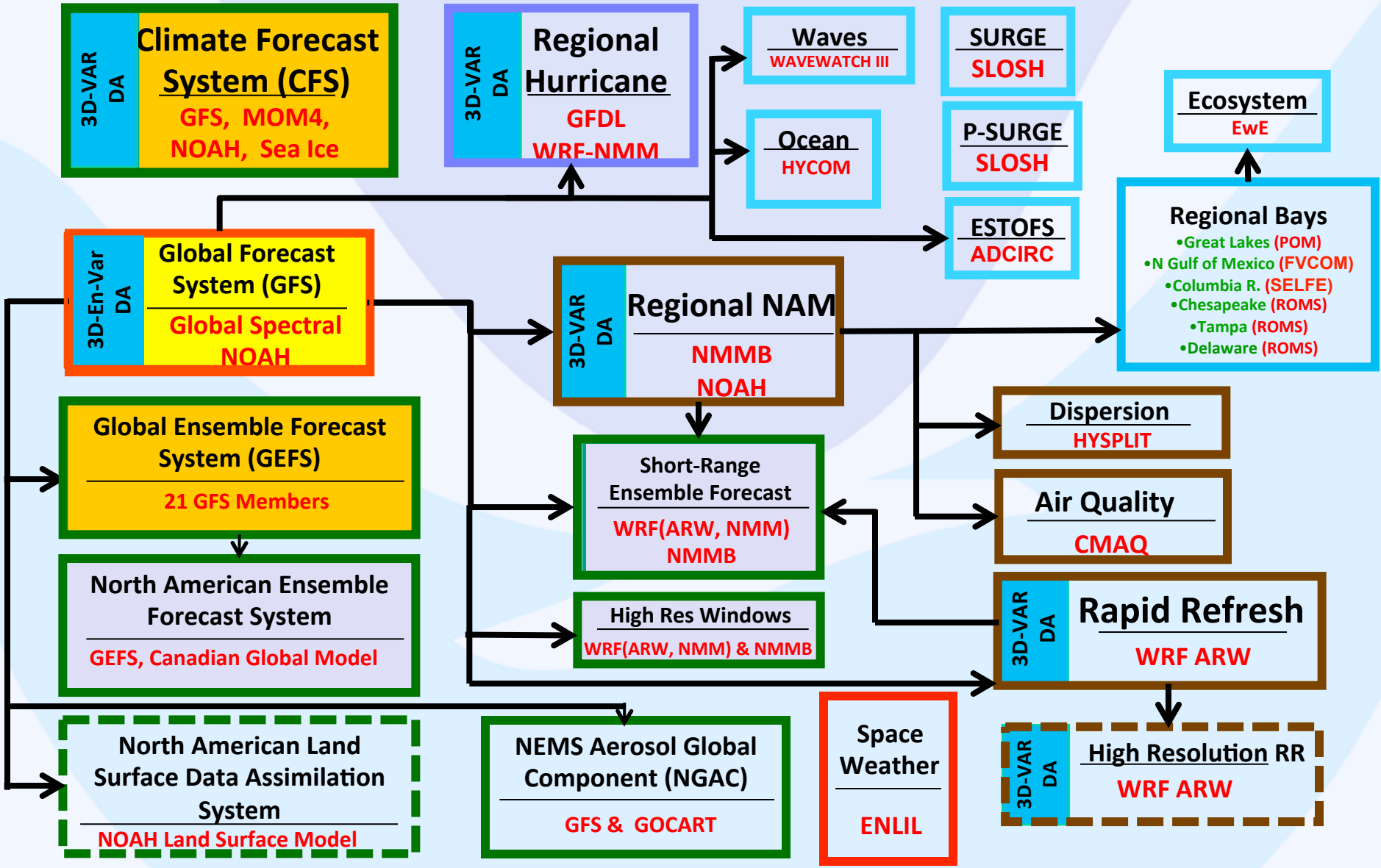
- What are we doing
- Where do we want to go
- Boulder Sea Ice Workshop
- Requirements and Commitments

What are we doing

Operational long term focus

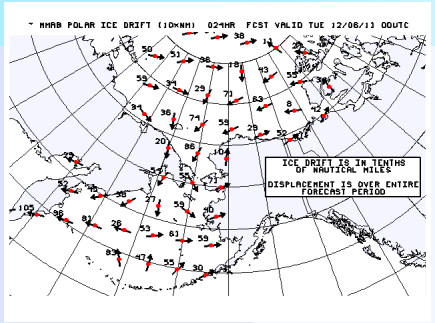
Seamless Suite, spanning weather and climate





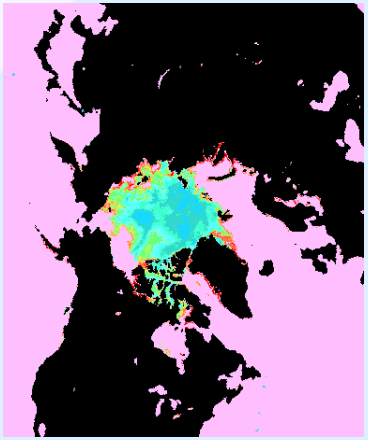
Production suite ca. January 2014

Sea ice products



Present products:

- Sea ice concentration.
  - ➤ Since 1996, now 1/12°.
- Sea ice drift model.
  - ➤ Ensemble approach 25km resolution.



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Stand alone products needed for many more years.

- Used in many weather models.
- Validation for ocean models,
- Other more appropriate producers ?

Ice modeling

Present ice “models” at NCEP:

- Sea ice drift model.

- NAM: ice/no ice field (constant in forecast).
- GFS: ice thickness evolves, concentration fixed, no velocity.
- CFS-v2: ice thickness, concentration and velocity evolve.

- WAVEWATCH III: constant ice concentration as model input.
  - ➤ Model allows for evolving ice input.

- RTOFS/HYCOM: Global: energy loan sea ice model.
- Arctic Cap Nowcast Forecast System (ACNFS, NANO/NRL, data available at NCEP) Los Alamos CICE model two-way coupled to HYCOM.

Ice modeling

In the pipeline:

- Collaboration with Navy:
  - Access to CICE direct in HYCOM.
- Collaboration with OAR:
  - ESRL Porting ice models to ESMF / NUOPC:
    - Los Alamos CICE.
    - GFDL SIS2 model.
  - ESRL-GSD RASM coupled model (CICE5)
  - GLERL: Coupled circulation – ice – wave model.
- In house:
  - CFS-V2 ice model.
  - Keep Ice'S Simplicity (KISS), introduced 2014, working with ERSL on ESMF.

Ice modeling

Justification for developing KISS:

- Predictability strongly linked to thermodynamics, secondary to ice drift.
  - ➤ Sea ice drift model ice edge at 72h forecast is as accurate as ACFNM full ice model at 24h forecast.

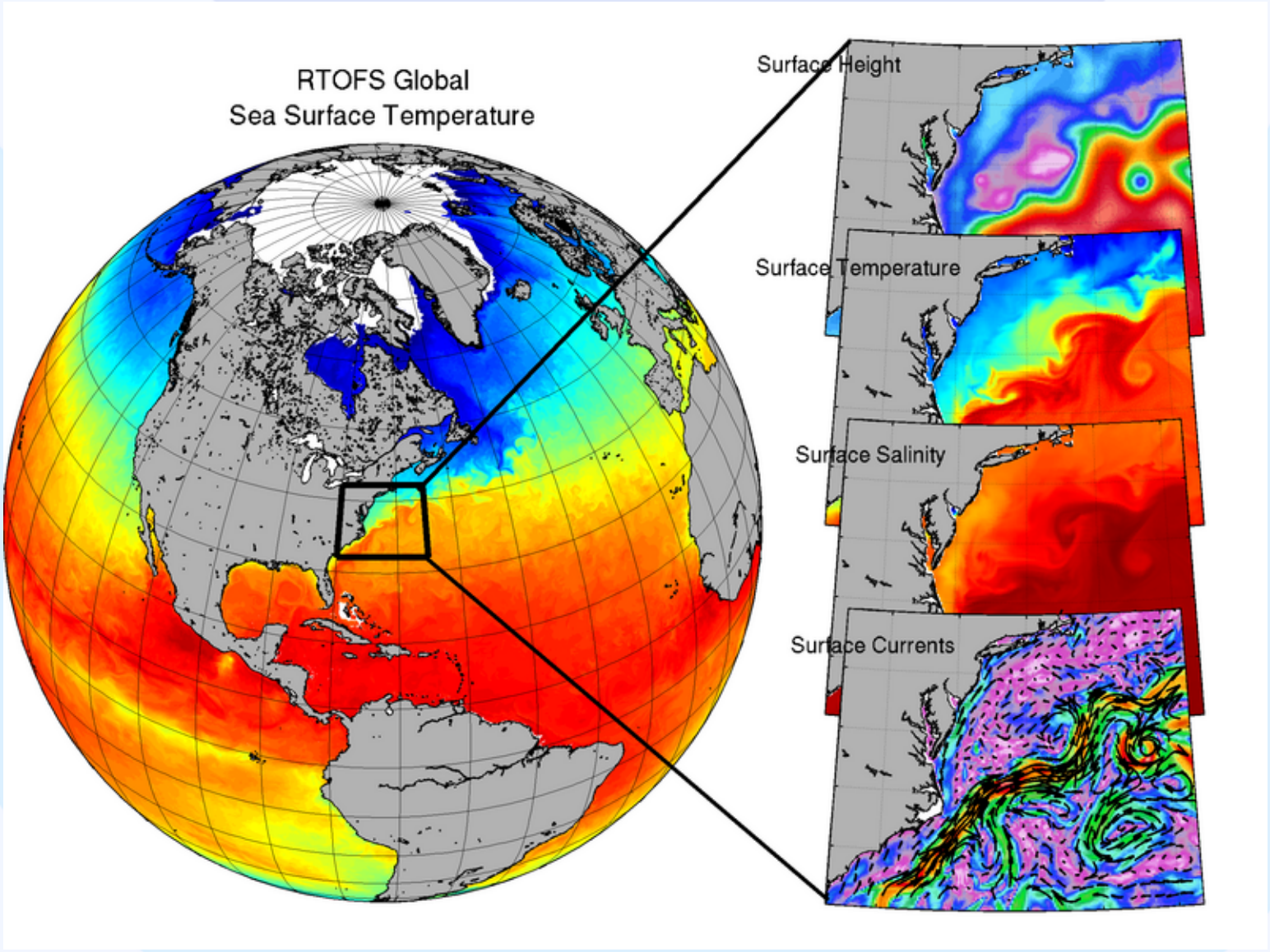
Metrics:

- Development of proper metrics key element of model development.
  - ➤ Development work ongoing
  - ➤ More to follow on 2014 NPSR.

Ice in coupled models:

- Major impact on weather in Canadian models.
  - ➤ Similar impact expected for Arctic and Great Lakes.
- Holding back ocean-atmosphere coupling on global scale.

RTOFS-Global



Where do we want to go

Operational long term focus

Basic issues / UMAC

The findings of the UMAC* pointed NCEP to the following observation:

The production suite has evolved as a set of solutions for (ill-defined) requirements, instead of a set of products serving well defined requirements.

* UCACN Model Advisory Committee

Basic approach : atmosphere

Start with weather side:

- We are NWS !

Starting with products:

- What forecast time ranges
- which reasonably imply
  - Run cadences
  - Update cycle.
- Not so clear:
  - Resolutions
  - Data Assimilation
  - Reforecast / reanalysis / retrospectives
- Need to map requirements to forecast ranges

Possible Approach			
Range	Target	Cadence	Means
year	Seasonal	?	9-15mo
month	S2S	6-24h	35-45d
week	Actionable weather	6h	3-16d
day	Convection resolving	1h	18-36h
hour	Warn On Forecast *	5-15 ‘	3-6h
now	Analyses **	?	now

* FACETs

** Separating from DA for models

Tentatively vetted at the Dec. 2015 NCEP Production Suite Review

Basic approach : coupling

This is not just a science problem

- Requirements for additional, traditionally downstream products
- '"One-way" model coupling versus downstream model:
  - Increases forcing resolution of downstream models while reducing I/O needed to force models
  - Creates a better integrated test environment for holistic evaluation of model upgrades
  - Less implementations
  - Creates environment for investigating benefits of two-way coupling. Enables two-way coupling if science proves benefit

Negative aspects of coupling:

- More complex implementations
- Less flexibility to tailor product.
- Produce "too much" compared to tailored products (forecast range)

Basic approach : DA

Unifying on GSI and ensemble hybrid 4DVAR.

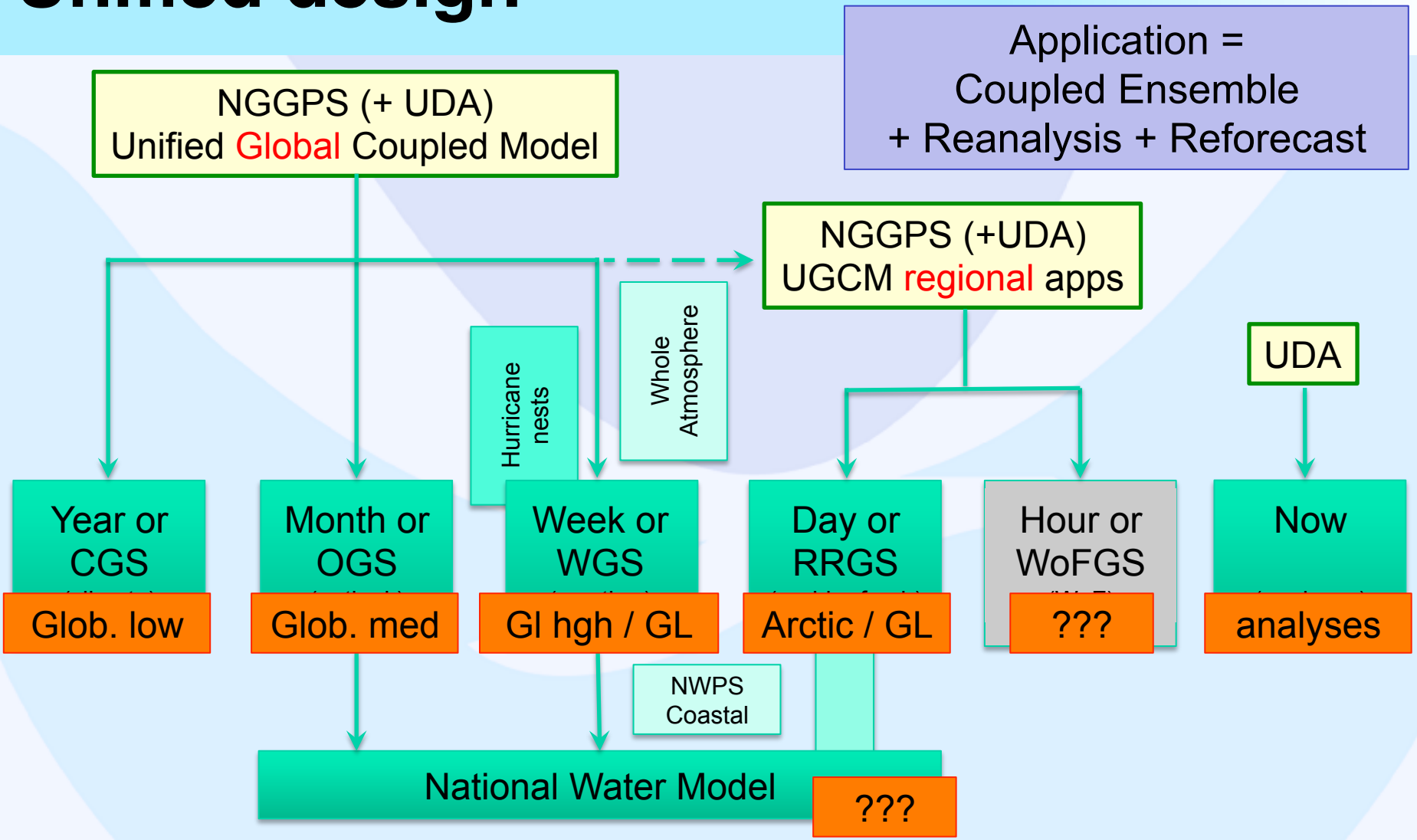
Global focus:

- Is a single DA system for all global models feasible?
- Where do we go with coupling
- JEDI (Joint Effort for DA Integration) JCSDA
- Issues:
  - Scaling of GSI, going to Resolution of underlying ensemble

Regional focus:

- We do want to unify, but how feasible is this?
- Great progress with convection resolving, but
- not yet at the science level achieved at global scales
  - Ensemble based convection resolving DA ….
  - Hourly WoF, many efforts, no real link to production suite yet

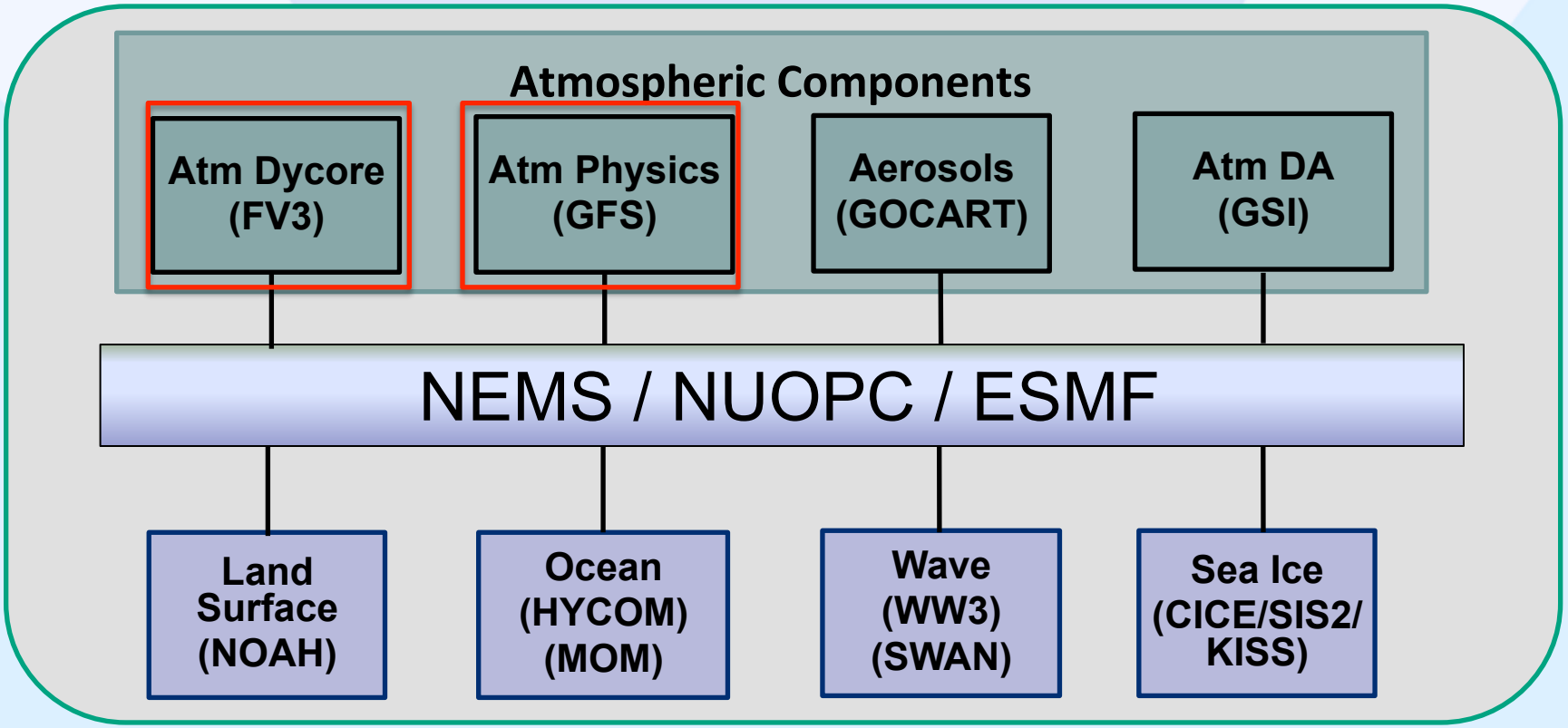
Unified design



UDA: Unified Data assimilation
CGS: Climate Guidance System
OGS: Outlook Guidance System

WGS: Weather Guidance System
RRGS: Rapid Refresh Guidance System
WoFGS; WoF Guidance System

NGGPS/UGCM and NEMS / ESMF

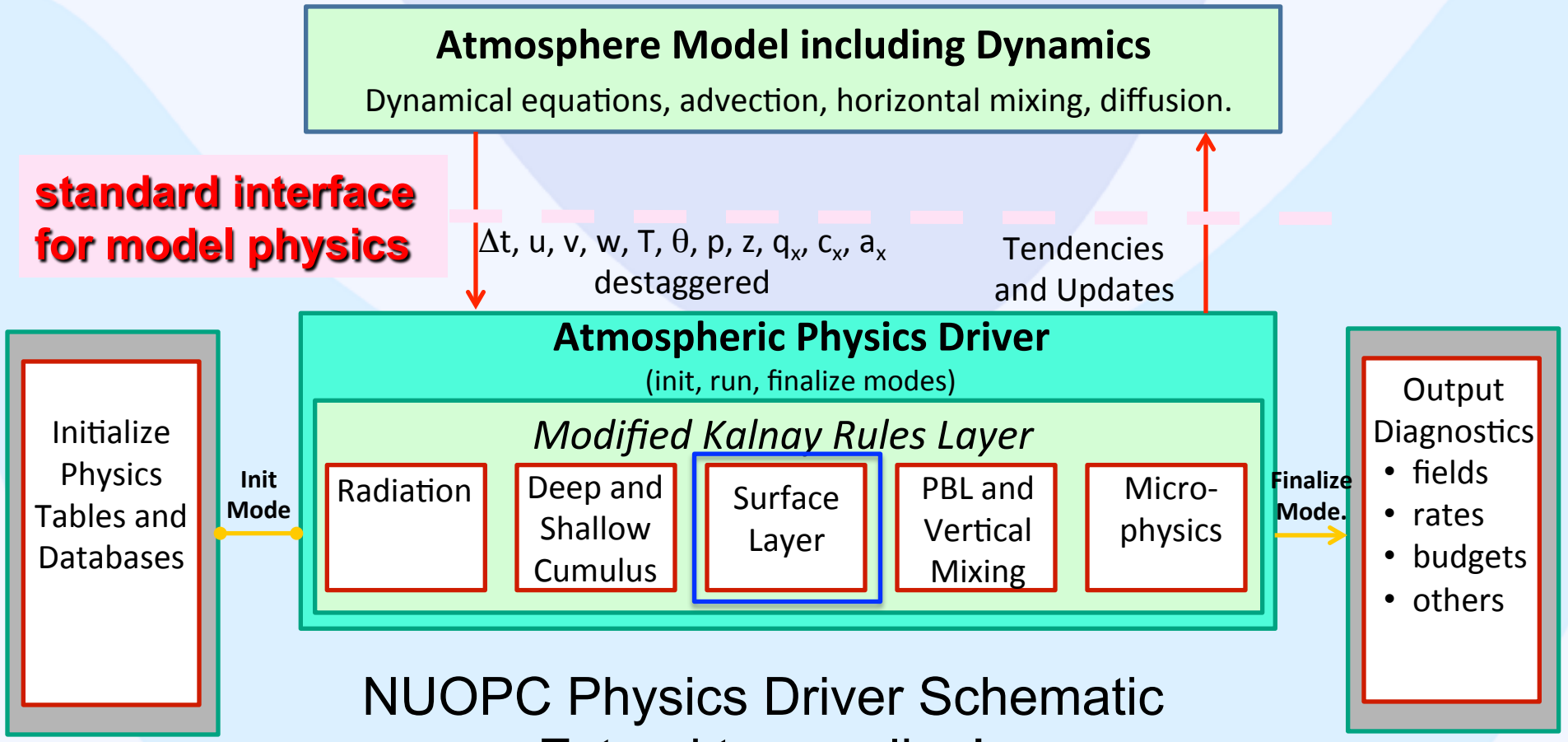


Modular modeling, using ESMF and NUOPC to modularize elements in a fully coupled unified global model

(+ *NWM, ionosphere , ecosystems , ……*)

NGGPS physics

Scale aware
Stochastic
"Unified"



NUOPC Physics Driver Schematic
Extend to coupling!

DTC support as CCPP

Sea Ice Workshop

NGGPS, Boulder , Feb 2-4, 2016

From NWS Executive report-out

Take home messages

Twelve ice modeling efforts presented

- More than half LANL CICE based, both model version 4 and 5
- SIS2 (GFDL) and KISS (EMC) suitable for operations
- Other models (PIOMAS, EC, …) not suitable for operational transition due to incompatibility with NCEP operations, lack of documentation, etc.
- Healthy discussion on model validation
  - Need acknowledged
  - Light on details on actual metrics
- Acknowledgment that more effort needed on weather time scales

Take home messages (CICE)

Advantages

- Recommended by community, large user community
- Available and used at EMC (RTOFS-global, NEMS)

Issues:

- Issues with versions, versions of ESMF
- Issues with grid choices (B versus C grids)

Possible showstoppers:

- Governance: This is a DOE / LANL model, with internal governance only. DOE plan
  - ➤ Go to MPAS_CICE on other (voroni) grid
  - ➤ No plans for CICE 6, instead limited support for “columnized” development (MPAS centric)
  - ➤ ONR willing to explore DOE-Navy-NOAA consortium for CICE governance / support.

This is why we are here !

Take home messages (SIS2)

Advantages

- Readily available at EMC from GFDL
- Grid compatible with ocean models

Issues

- Not recommended by community
  - Only two developers at GFDL, no intend for long term support
  - Embedded in MOM6, not clear how easy to separate / transition to modular approach

Possible showstoppers:

- Short term benefit offset by long term support
- Will have to develop community support

Take home messages (KISS)

Advantages

- Build in ESMF / NEMS
- Could conceivably by combined with future “columnarized” version of CICE, (MPAS dependency?)
- Much cheaper than CICE and SIS with focus on predictability on weather time scales
- Predictability focus, better at day 3.

Issues

- No clear guidance from community
- EMC, not community model

Possible showstoppers:

- Short term benefit offset by long term support?
- Will have to develop community support

Requirements / Commitments

February 2016

NOAA wish list

Community model approach for ice modeling framework

- Column and grid separated.
- Framework with exchangeable grid approaches

True community modeling framework.

- Clear planning of upgrade / contribution path

Commitment:

- First and foremost in-kind based on contributions.
- NWS/OSTI time for governance
- Support dedicated code manager ?


Thank You!